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LEARNING SETS IN PROGRAMMED INSTRUCTION. FINAL REPORT.

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TWO STUDIES ON LEARNING SET FORMATION IN CONTINUOUS, DISCOURSE-PROGRAMED MATERIAL WERE CONDUCTED. ONE STUDY WAS CONDUCTED WITH 315 COLLEGE STUDENTS, THE OTHER WITH 141 SIXTH-GRADE STUDENTS. THE MAJOR INDEPENDENT VARIABLE WAS THE NUMBER OF PROGRAMED UNITS ADMINISTERED. THE DEPENDENT VARIABLES WERE PRE- AND POST-ACHIEVEMENT TEST SCORES AND ERROR RATE. PROGRAMS PRESENTED TO THE SIXTH-GRADERS WERE ORDERED WHILE THOSE FOR THE COLLEGE STUDENTS VARIED. NO EVIDENCE OF LEARNING SETS WAS FOUND FOR THE SIXTH-GRADERS BUT ACHIEVEMENT AND ERROR RATE FOR THE COLLEGE STUDENTS VARIED AS A FUNCTION OF THE NUMBER OF PREVIOUS PROGRAMS EXPERIENCED, INDEPENDENT OF ORDER PRESENTATION. THE EFFECTS OF THE COLLEGE STUDY WERE POSITIVE FOR THE FIRST THREE PROGRAMS BUT TENDED TO BECOME NEGATIVE FOR THE LATER ONES. IT IS SUGGESTED THAT THE FINDINGS MIGHT BE A FUNCTION OF THE INTERACTION OF COGNITIVE, MOTIVATIONAL, AND ATTITUDINAL FACTORS. (PM)

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A FINAL REPORT

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LEARNING SETS IN PROGRAMMED INSTRUCTION

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SUMMARY

Two studies on learning set formation in continuous discourse, programmed material were conducted, one with a population of college students (N =315 and one with a population of sixth-grade students (N =141).

The major independent variable was the number of programmed units (from 1-7 for sixth graders and from 1-6 for college Ss) experienced by S. The dependent variables were an achievement test score and the error-rate for each program studied. In the study utilizing an elementary school population, programs were presented in a fixed order with a control for the effects of testing on achievement; while, in the study utilizing college students, the order in which programs were presented was varied.

No evidence of learning sets was found for the sixth graders; however, for college Ss, achievement and error rate varied as a function of the number of previous programs experienced independent of order of presentation of the programs. The effects were positive for the first three programs experienced and tended to become negative for a fourth, fifth, or sixth program.

It is suggested that the findings might be a function of the interaction of cognitive, motivational, and attitudinal factors.

THE PROBLEM

In an article which seems to have become one of psychology's classics, Harlow (1949) proposed an alternative to what he called "brilliant Blitzkreig research," or the "do and die technique," that is, the use of naive subjects exposed to short-term study in experiments in learning.

In the typical Harlow study, S is presented with a choice between two objects differing along one or more dimensions. When S picks up or knocks aside the correct object, he receives a food reward. The pairs of objects presented to S are changed throughout the experiment so that S may solve two hundred or more problems consisting of a great many different pairs during the course of an experiment. Harlow found that Ss improved greatly in their ability to solve the discrimination problems, frequently reaching a point of near perfection of choice on the last block of trials. Harlow named the interproblem improvement, the learning how to learn to solve problems, learning set (LS). For Harlow, the learning of primary importance is "the learning how to learn efficiently in the situations which the animal frequently encounters." (p.51) In this article, Harlow argued that, "the behavior of the human being is not to be understood in terms of the results of single learning situations but rather in terms of the changes which are affected through multiple, though comparable, learning problems." (p.51) Harlow (1959) and Harlow and Hicks (1957) have developed this view further. In the intervening dozen years, a considerable literature of research on this phenomenon in animal subjects and human children has developed; yet, studies of LS in which continuous discourse material has been used are rare. The

studies in which human subjects have been used, ordinarily parallel closely, Harlow's studies with infra-human primates in technique and type of stimulus material used.

In a sense, this body of literature has served to establish a firm conviction that learning how to learn is an important consideration in understanding human learning and it is fashionable indeed to drop the name, "learning sets," when speculating about the factors which enter into learning by humans. This conviction, however, is largely unsupported by data on the learning of meaningful materials by humans. This point has been made in several recent articles on learning. For example, Postman (1961) states, "thus far, there has been only very limited progress in the analysis of the classes of habits which constitute learning how to learn. It is essential, however, in the design and evaluation of specific training procedures to take account of the progressive development of learning skills." (p.76) (Italics added.) Carpenter, et al. (1962) proposes that research with humans is required on, "the problems of training individuals in the instrumental skills of 'learning how to learn,' including 'sets' and positive attitudes. . . using media where appropriate." (p.42) Glaser (1961, 1962 (a), 1962(b)), Travers (1954), Kendler (1961), Gagné (1962), and Gagné & Paradise (1961), among others, have supported the view that there is considerable potential in pursuing studies of the LS concept in humans. Carpenter et al. report that in the several conferences which were held for the purpose of determining the need for media research centers, "the opinion was often expressed that the gap between general theories and principles of learning and experimental findings, and their applications to meaningful

human learning must be bridged." (p.24) "Learning how to learn," based largely on experimental findings from animal subjects, represents a promising area for attempting the bridging.

The purpose of this study is to determine whether or not LS occurs when humans learn "blocks of knowledge" in self-instructional form. A demonstration of the existence of a learning to learn phenomenon for meaningful, verbal material will permit further investigation of manipulable variables controlling such sets and lead to the development of methods and procedures for increasing the efficiency with which Ss learn how to learn concepts through the medium of programmed instruction.

Lawson (1960) writes, ". . .learning how to learn. . . is undoubtedly an important aspect of human learning. So far, we lack enough information to utilize this phenomenon for practical ends. It has only begun to be studied relatively recently, and so the variables that affect the process are hardly known at all." (p. 241)

Gagné and Paradise (1961) and Gagné (1962) in a discussion of this problem relate it clearly to programmed learning, its development and its use. These investigators propose that the learning which results from the use of programmed instruction be called "productive learning." In this form of learning, "measures of terminal performance are designed to demonstrate mastery of the defined class of tasks" (p.1) rather than mastery of the specific task practiced during training. Gagné and Paradise argue that the findings from studies of the type proposed here will help in structuring the learning sequences of programs, in diagnosing the strengths and the weaknesses of self-instructional programs, and

in measuring the achievement of learners more precisely. This work seems to have relevance to other educational media of instruction such as filmed sequences or taped sequences of "blocks of knowledge."

RELATED RESEARCH

The phenomenon of learning sets clearly is related to the familiar problem of the transfer of training although it should not be equated with the latter. Stephens (1960) in a review of the literature on transfer of training refers to LS as a "very primitive form of transfer" which occurs when "the learner works on a series of complex but similar problems." (p. 1538) For Harlow, LS consists of the elimination of responses and response tendencies inappropriate to a particular learning situation. Morrisett and Hovland (1959) hypothesize that LS is "the learning of a single class of habits to a complex set of cues." (p.55) McDonald (1959) relates LS to the role of familiarity in the learning of generalizations in that "familiarity is likely to be produced by exposing students to the materials and allowing them to explore and manipulate the materials. . .that in such exploratory periods an individual can 'learn how to learn.'" (p.177) Several other writers relate, but do not equate, LS to transfer. (See for example, Bugelski (1956), Cronbach (1963), Lawson (1960), and Woodworth and Schlosberg (1954)).

There is general agreement that learning to learn is inter-problem learning (sometimes called interproblem transfer or generalization between problems) rather than intra-task transfer. Further, there is agreement generally that the inter-problem transfer is positive and is concerned primarily with the transfer of "method" rather than the transfer of "content." Since the prevailing

views of LS sets this concept in the domain of transfer of learning, but as a special case, no attempt will be made to review the literature on transfer per se. Instead, only those studies in which the Ss were human and for which the findings provide support for a LS concept will be discussed. Studies of LS in infra-human primates have not been excluded arbitrarily; they have been replicated on children to a large extent (Kendler (1961) has reviewed many of these).

One of the earliest studies usually cited as providing evidence for LS in humans is that of Woodrow's (1927) in which one group of college students was taught new methods of "memorizing" and, following training, the group was compared with two control groups on achievement in new verbal tasks. The trained group was more efficient in "transfer" or "generalizing" and in recent years these results for the trained group have been attributed to the formation of a learning set (Cronbach, 1963). Similar findings for the learning of motor skills were reported by Cox (1933) who provided Ss with observation exercises designed to increase attention to cues. All of the training was given on a single task and no direct training of subskills was provided; yet, this group was more successful on subsequent tasks than either a group trained directly on subskills or a group given equal training time on the training task. Practice on one skill led to much more rapid learning of a dissimilar motor skill, i.e. a LS was formed. Ward (1937) found changes in the rate of learning successive lists of twelve nonsense syllables. A rapid decrease in the number of trials to learn to criterion was found for the first six lists and further improvement occurred for the remaining lists. Reed (1946) reported

that instructions to learn concepts facilitated the learning of concepts and concluded that S can alter his scanning of the stimuli produced by his "mediating stimulus produced responses." Learning to learn is the interpretation proposed by Gormezano and Abraham (1961) for the finding that Ss who were required to name forms, colors, or numbers improved their performance significantly on the last three stages of the training task. Finally, in a recent book on concept learning as an information process, Hunt (1962) refers to several studies in which there was reported to be an improvement in the mediating response in learning concepts and derives from these and studies on concept learning, a "heuristic system that learns to learn." (pp. 265ff).

The sample of studies reviewed above indicate clearly that the formation of learning sets in the human can be demonstrated, however, in none of these was continuous discourse material used; instead, the tasks consisted of naming colors, discriminating geometric forms, identifying numbers, learning lists of nonsense syllables, learning lists of the Turkish equivalents of English words, and learning skills related to assembly of objects. Presumably LS can be demonstrated for more meaningful material learned under non-laboratory conditions.

Reynolds and Glaser (1964) report a study in which they tested the hypotheses that (a) "learners of high intelligence and prior school achievement would not demonstrate differences in achievement and response accuracy as practice learning from programmed instruction accrued, but that (b) learners of average intelligence and average prior school achievement would demonstrate improvements in achievement and response accuracy with increased practice

in programmed instruction." (p.2) Ss were matched for high and low intelligence for one comparison and for high and low achievement on the Cooperative Science Test for another. Three units of junior high science (1290 frames) were presented to Ss in two orders. No significant differences in achievement were found as a function of the amount of experience with programmed instruction. An analysis with error rate rather than achievement as the dependent variable indicated the possible formation of learning sets for a unit on "measurement" but not for a unit on "sound." Since the error rate on the latter ranged between 4 and 15 per cent while the error rate on "measurement" ranged from between 5 and 26 per cent, the investigators conclude that learning sets are likely to be demonstrated only on programs with a high error rate, i.e., on difficult tasks.

Gagné and Paradise (1961) have reported a study in which programmed instruction was used to extend and test one of the conclusions drawn from a study of factors related to the preparation of programmed material for the learning of concepts. (Gagné and Brown, 1961) Gagné and Paradise define a learning program as a class of tasks and hypothesize that there is a "hierarchy of learning sets" which S must acquire if he is to be proficient on the class of tasks as a whole. The theory which they propose is

> "attainment of any given learning set is dependent on recallability of certain subordinate learning sets, instructions defining the stimuli and goal of the new task, and integration by the learner of subordinate learning sets into the solution of the new task. Subordinate learning sets are conceived as having the function of mediating positive transfer to higher level learning sets throughout the hierarchy, and ultimately to the final task." (p.16)

In this analysis, learning sets are not equated with transfer,

per se; instead, they are considered to be mediators of positive transfer. We might refer to LS in this analysis as intra-class LS as contrasted with (a) inter-class LS, which will be discussed below, or (b) inter-problem LS or inter-task LS such as has been reported for studies of the Harlow type, several of which have been reviewed above.

Gagné and Paradise analyzed an existing program on linear algebraic equations and defined twenty-two learning sets for the program by obtaining an answer to the question, "What would the individual have to be able to know how to do, in order to be able to perform this (new) task, being given only instructions?" The question is answered first for the final task of the "class" and then successively for each succeeding new task in the program, working backwards. They were able to obtain empirical support for their technique and the theory. "Instances of positive transfer to each learning set from subordinate relevant learning sets were found to occur throughout the hierarchy. . ." (p.18) Gagné (1962) in a provocative article on "The Acquisition of Knowledge," discusses the implications of the theory of learning set hierarchy for programmed instruction. It seems to the writers that the theory has implications for the preparation and the utilization of other instructional media, for whenever valid identification and measurement of subordinate sets can be made, it should be possible to prepare material categorized by subordinate sets within the hierarchy making up the class of tasks, and to assign learners the materials for only those subordinate sets in which they fail to show proficiency.

Gagné's theory can be extended to include inter-class LS,

that is, the formation of learning sets from discrete sets of taped, filmed, or programmed instructional sequences. The question to be answered is, "Can it be demonstrated that learners not only acquire intra-class LS but also that they 'learn how to learn' intra-class LS, as it were?" It is proposed that there are generalized learning sets associated with mode of instruction, at least, and that these can be identified, isolated, and studied as a higher level "inter-problem learning" using properly constructed, existing learning programs. (For a related discussion, see Stolurow, 1964, pp. I2 - I4.)

PURPOSES OF THE STUDY

1. To identify intuitively and validate empirically the hierarchy of learning sets required for proficiency in each of six brief, and relatively discrete sequences of programmed material (intra-class learning sets).

2. To determine whether a learning set is formed for programmed instruction qua programming (inter-class learning set).

3. To determine whether there are differences in retention on the nth learning program as a function of the number of learning programs which S has studied.

IV STUDY ONE--COLLEGE POPULATION

1. Subjects

The Ss were 315 (235 males, 80 females) freshman and sophomore students enrolled in three sections of introductory psychology. The Ss were stratified on the basis of sex and assigned randomly to one of forty-five experimental groups (n=7 for each group). Since two instructors were involved, equal numbers of Ss per instructor were assigned to each group.

In order to provide comparable extrinsic motivation, Ss were informed that attendance at research meetings and completion of the experimental materials were required to receive a passing grade in the course. Because of absences at critical points in the experiment, four Ss were lost from the original population.

2. Materials

Six programs which were relatively novel were used. Table 1 includes the titles of the programs and the number of frames contained in each.

Table 1

Program Titles and Number of Frames in Each

Program	Frames
Chinese History	123
Programmed Instruction	113
Sentences (Logic)	154
Federal Relations in Education	96
Russian Alphabet	150
Set Theory	187

Tests were constructed by E to parallel criterion items within the programs. These tests were used in pre- and post-assessment. Appendix C includes copies of the programs and tests.

Density and type-token ratios were computed for each program. Density was determined by selecting the first forty responses, middle forty responses and the final forty responses and dividing the total number of different responses by the total number of responses. Table 2 presents the programs in order of increasing density.

Table 2

Program density and order

	Density	Program Number
Chinese	.36	1
Logic	.62	2
Fed. Rel.	.73	3
Prog.	.75	4
Russian	.77	5
Sets	.78	6

On the basis of the order in Table 2, the programs were assigned numbers which were used later in the design.

A type-token ratio for each program was obtained by selecting a sample of 100 frames (excluding answers) and dividing the total number of different words used in the 100 frames by the total number of words in the sample. Table 3 includes these data.

Table 3

Type-Token Ratio for Each Program

Program Title	TTR
Chinese	.40
Logic	.395
Fed. Rel.	.64
Prog.	.61
Russian	.34
Sets	.54

Since density refers to the amount of redundancy in responses required while the type-token ratio refers to the amount of redundancy within frames, it was decided to order the programs in terms of the former (Green, 1962).

3. Procedure and Experimental Design

Using a modified Latin Square design (Table 4), programs were assigned to each of the experimental groups. The design made possible the analysis of achievement on each program, with the number and the subject matter of preceding programs varied. Thus, Ss went without experimental programs at certain points in the experimental design. Fifteen groups were given all six programs, each group receiving them in a different order while fifteen additional groups received only two of the six programs, again in a variety of orders. The third set of fifteen groups received four of the six programs, with order varied.

Table 4

Design of the Study*

Group	Program Order	N	Group	Program Order	Group	Program Order
A1	1 2 3 4 5 6	(7)	B1	2 4 6 1 3 5	C1	3 6 2 5 1 4
A2	0 2 3 0 5 6	(7)	B2	0 4 6 0 3 5	C2	0 6 2 0 1 4
A3	0 0 3 0 0 6	(7)	B3	0 0 6 0 0 5	C3	0 0 2 0 0 4
D1	4 5 6 1 2 3		E1	1 3 5 2 4 6	H1	5 1 4 3 6 2
D2	0 5 6 0 2 3		E2	0 3 5 0 4 6	H2	0 1 4 0 6 2
D3	0 0 6 0 0 3		E3	0 0 5 0 0 6	H3	0 0 4 0 0 2
J1	4 1 5 2 6 3		K1	5 3 1 6 4 2	M1	6 5 4 3 2 1
J2	0 1 5 0 6 3		K2	0 3 1 0 4 2	M2	0 5 4 0 2 1
J3	0 0 5 0 0 3		K3	0 0 1 0 0 2	M3	0 0 4 0 0 1
Q1	2 6 3 4 1 5		R1	6 4 2 5 3 1	S1	3 2 1 6 5 4
Q2	0 6 3 0 1 5		R2	0 4 2 0 3 1	S2	0 2 1 0 5 4
Q3	0 0 3 0 0 5		R3	0 0 3 0 0 1	S3	0 0 1 0 0 4
T1	2 3 4 5 6 1		X1	6 2 5 1 4 3	Z1	4 1 6 3 5 2
T2	0 3 4 0 6 1		X2	0 2 5 0 4 3	Z2	0 1 6 0 5 2
T3	0 0 4 0 0 1		X3	0 0 5 0 0 3	Z3	0 0 6 0 0 2

*The design of the study includes both the traditional transfer of learning paradigm and the typical paradigm for the formation of learning sets; hence, it is possible to determine (a) the amount of transfer of learning from one program to another, within the orders specified and (b) the amount of learning to learn as a function of the number of preceding learning programs with which S has had experience.

Each weekly work session totaled 110 minutes*. Table 6 presents a breakdown of the procedure within one work period.

Table 5

Weekly Laboratory for Each S

Distribution of materials	5 min.
Ss Work on the Pre-test	15 min.
Ss Work on the Programs	75 min.
Ss Work on the Post-test	15 min.

4. Data Obtained

Pre-test scores, post-test scores, working time per program, and grade point average were obtained for each S.

* See Appendix A for the instructions to Ss.

RESULTS

Linear models were developed for gains in achievement (post-test score minus pre-test score) and for error rate. Variables included in the linear models were:

X_1: Sex

X_2: Grade Point Average

X_3: Instructor

X_4: Post-Test, Program 1

X_5: Post-Test, Program 2

X_6: Post-Test, Program 3

X_7: Post-Test, Program 4

X_8: Post-Test, Program 5

X_9: Number of Previous Programs

X_{10}: (Number of Previous Programs)^2

Y_1: Gain (post - pre)

Y_2: Error Rate

The linear equation for gain in achievement is:*

$$\hat{y}_1 = 17.14 - \underset{***}{1.58}\, x_1 + \underset{**}{.98}\, x_2 + \underset{NS}{.06}\, x_3 - \underset{***}{2.30}\, x_4 + \underset{***}{2.79}\, x_5 - \underset{**}{1.00}\, x_6 - \underset{***}{5.35}\, x_7 + \underset{***}{7.91}\, x_8 + \underset{***}{1.02}\, x_9 - \underset{*}{.14}\, x_{10}$$

The equation for error rate is:

$$\hat{y}_2 = 7.65 + \underset{*}{1.28}\, x_1 - \underset{NS}{.18}\, x_2 + \underset{*}{1.64}\, x_3 + \underset{***}{7.43}\, x_4 - \underset{***}{6.91}\, x_5 + \underset{***}{2.29}\, x_6 + \underset{NS}{.67}\, x_7 - \underset{**}{1.30}\, x_8 + \underset{**}{1.15}\, x_9 - \underset{***}{.40}\, x_{10}$$

---

* All variables (parameters) for the equations plus the coefficients and the t values for each coefficient are given in Appendix D.

The significance of each parameter estimate in the equations above is symbolized as follows:

NS: Not significant

*: Significant at the 5% level

**: Significant at the 1% level

***: Significant at the .1% level

In summary form, the equations indicate that the following variables were significant:

	Gain (y_1)	Error Rate (y_2)
Sex	.001	.05
GPA	.01	NS
Instructor	NS	.05
Previous Programs	.001	.01

Additional statistics regarding the fit of these linear equations are:

Equation	Standard Error $\hat{\sigma}_e$	Standard Deviation of y	Multiple Correlation
1	6.41	8.26	.635
2	8.75	9.96	.485

Obviously, not all of the variation in y_1 or y_2 is explained by the linear models but certain effects have been established as significant.

In interpreting the equations, one can estimate the expected response for a particular set of inputs as follows:

$$\hat{y}_1 = 17.14 - 1.58 \text{ (if male)} + .98 \text{ (G.P.A.)} + .06 \text{ (if G)} + 1.02 \text{ (No. of prev. programs)} - .14 \text{ (No. of prev. programs)}^2 + \begin{bmatrix} \text{Post-} \\ -2.30 \text{ if test 1} \\ +2.79 \text{ if test 2} \\ -1.00 \text{ if test 3} \\ -5.35 \text{ if test 4} \\ +7.91 \text{ if test 5} \\ -2.06 \text{ if test 6} \end{bmatrix}$$

$$\hat{y}_2 = 7.65 + 1.28 \text{ (if male)} - .18 \text{ (G.P.A.)} + 1.64 \text{ (if G)} + 1.15 \text{ (No. prev. programs)} - .40 \text{ (No. prev. programs)}^2 + \begin{bmatrix} \text{Post-} \\ +7.43 \text{ if test } 1 \\ -6.91 \text{ if test } 2 \\ +2.29 \text{ if test } 3 \\ +\ .67 \text{ if test } 4 \\ -1.30 \text{ if test } 5 \\ -2.17 \text{ if test } 6 \end{bmatrix}$$

For example, consider a male with 3.0 G.P.A. and instructor T, taking test 4, having taken 3 previous tests:

$$y_1 = 17.14 - 1.58 + 2.94 + 0 - 5.35 + 3.06 - 1.26 = 14.95$$

$$y_2 = 7.65 + 1.28 - .54 + 0 + .67 + 3.45 - 3.60 = 8.91$$

Note that in finding the parameter estimate for test 6, we set $x_4 = x_5 = x_6 = x_7 = x_8 = -1$ in each equation. This is because of the restriction that the effects of program type sum to 0. Note also that the effect of number of previous programs is positive at a decreasing rate for y_1, and apparently also for y_2, but in the latter case the effect is really negative for more than three previous programs. Most of the coefficients are of opposite signs for the two equations as might be expected.

V STUDY TWO - SIXTH GRADE POPULATION

1. Subjects

Five sixth-grade classes containing a total of one-hundred forty-one students (73 females, 68 males) served as Ss.* The California Test of Mental Maturity and the California Achievement Test (Reading Comprehension) were administered to each S for later use as control variables in co-variance analyses. The mean IQ for the group was 107 and the mean grade placement in reading was six years-nine months.

2. Design and Treatment

Subjects were randomly assigned to four groups to obtain

the N's per group shown in the research plan in Table 6. Since Ss were drawn from five classrooms, a control for this factor was provided by having proportionate numbers of each of the four experimental groups in each classroom.

The design given in Table 6 makes it possible to determine (a) the amount of transfer of learning from one program to another, within the order specified and (b) the amount of learning to learning as a function of 2, 4, or 6 preceding learning programs. Further for the first six weeks, hence, for the first six programmed units, Group 4 serves as a control for the effects on achievement

TABLE 6

Research Plan

Group	N	Week			
		1 & 2	3 & 4	5 & 6	7
1	48	1,2*	3,4	5,6	7
2	41	Pre- and Post-tests	3,4	5,6	7
3	28	Pre- and Post-tests	Pre- and Post-tests	5,6	7
4	28	Pre- and Post-tests	Pre- and Post-tests	Pre- and Post-tests	7

*Program numbers, where:
1. Music
2. Mammals
3. Weather
4. Solar System
5. Number Theory
6. Fractions
7. Insects

of taking the pre- and the post-tests without exposure to the programmed material.

The seven programmed units were selected to meet the following criteria:

(a) Relatively novel subject matter at a level appropriate for the sixth grade.

(b) Field-test data on each unit were available.

(c) A broad range of tasks was represented, i.e., no more than two programs each were to be drawn from the same domain of knowledge, e.g. physical science, biological science, mathematics, humanities, or social science.

(d) The direct overlap in content, concepts, and principles among programs must be minimal to provide seven relatively discrete tasks, a requirement which must be met if interclass learning is to occur.

(e) The content of each unit has been so structured that Ss cannot achieve well on test items on the last quarter of the program without working through the first three quarters of the program.

(f) Each program had to be linear and it had to contain one or more criterion frames for each concept taught and it had to teach enough concepts to make it possible to construct criterion tests containing a minimum of twenty-five items.

The density ratio and the type-token ratio for each program were calculated and they are presented in Table 7.

TABLE 7

Density and type-token ratio for each of seven programs used

Program Title	No. of Frames	Density	Type-token ratio
1. Music	145	.23	.31
2. Mammals	127	.30	.38
3. Weather	96	.30	.38
4. Solar System	111	.37	.47
5. Number Theory	135	.37	.49
6. Fractions	115	.41	.58
7. Insects	82	.51	.58

As was the case in Study One, programs were presented in order of increasing density.

3. Procedure

The E met with the five classroom teachers for one-hour of orientation on the procedures which were to be followed in conducting the research. The procedures were designed to keep teacher participation or interference at a minimum. A folder was prepared for each S and the folders were placed in alphabetical order for each class. Printed instructions and the appropriate tests and programmed material was placed in each S's folder weekly (See Appendix E). The Ss were instructed to remove Test 1 (the pre-test) from their folders on Monday and to complete the test. Those who were to work on a programmed unit, were instructed to complete the unit during a "study period" on Tuesday, Wednesday, and on Thursday (if more time was required). Those Ss who were not working on programs in a given week, spent their study period on

other subjects. All Ss in a class took the post-test on Friday. This procedure was followed on all seven weeks of the study. Two research assistants monitored the classrooms periodically throughout the seven weeks. Teachers and pupils adhered to the procedures carefully; hence, no difficulty was experienced during the study except that these sixth graders seemingly were unable to record accurately the time which they spent on each program.

The post-test for Program Seven (Insects) was re-administered to all Ss four weeks after they had completed work on that program as a check on retention as a function of the amount of experience with programmed material.

VI - RESULTS

1. Intra-class Learning Sets

Each of the programs selected for use in this study was expected to meet the criterion of a hierarchy of concepts such that success on one stage or level would be difficult unless the preceding stage had been mastered, at least, in part. Each of the programs selected was studied thoroughly beforehand and was included in the study because it seemed to meet this requirement. Indirect evidence in support of intuition is presented in Table 8. Group I, the group which received all seven programs, and Group IV, the group which received only the seventh program, are compared on the mean number of errors on the first ten items and on the last ten items of each achievement test. Each achievement test consisted of items paralleling the criterion items of each programmed unit, with the test items arranged in the same order as were the concepts in the program. For all six programs, Group IV failed more items among the first ten and the last ten items on each

TABLE 8

Number of errors on first and last ten items of each achievement test for six programs

	$\bar{X}$ errors on Item 1-10	$\bar{X}$ errors on last 10 items
Numbers		
Gr. I	4.30	6.39
Gr. IV	5.85	9.03
Fractions		
Gr. I.	2.26	4.11
Gr. IV	2.92	6.35
Music		
Gr. I	2.26	5.54
Gr. IV	3.19	7.29
Animals		
Gr. I	4.60	5.07
Gr. IV	5.80	7.78
Solar System		
Gr. I	3.71	5.11
Gr. IV	3.94	8.36
Clouds		
Gr. I	3.60	4.24
Gr. IV	4.62	7.18

test than did Group I which indicates (a) that experience with the program contributed something to success on the early items of each test and (b) experience with the program contributed heavily to success on the last ten items of each test.

2. Inter-Class Learning Sets

The mean scores for the control variables of IQ and reading comprehension, the pre-tests, the post-tests and the retention tests for each of the four groups are presented in Table 9. From inspection, it is evident that each program was a reasonably effective teaching instrument although the ceiling of each achievement test was approached only for the programmed unit on music.

TABLE 9

Mean control variable, pre-test, post-test, and retention score by group

	GROUP			
	I	II	III	IV
IQ (CTMT)	109.28	107.34	105.00	107.57
Reading Comprehension	6.98	6.96	6.78	7.14
1. Music pre-test	19.63	17.34	19.68	19.29
Music post-test	28.15	19.58	21.75	19.93
2. Mammals pre-test	11.48	12.07	12.68	12.18
Mammals post-test	21.35	13.15	13.57	13.46
3. Weather pre-test	9.26	9.63	10.07	9.96
Weather post-test	15.00	14.27	11.11	11.37
4. Solar System pre-test	13.80	11.68	11.61	12.50
Solar System post-test	21.02	18.95	13.04	13.29
5. Number Theory pre-test	8.13	8.66	7.86	6.89
Number Theory post-test	15.39	14.90	15.25	7.59
6. Fractions pre-test	18.35	17.34	16.26	16.61
Fractions post-test	22.65	22.40	20.63	17.48
7. Insects pre-test	11.83	10.88	11.59	12.33
Insects post-test	19.67	18.49	19.30	21.57
Retention Test	18.17	16.44	17.26	18.74

It would appear from an inspection of the sets of means placed in boxes, that the differences among groups as a function of experience with programmed material were very small and random. An analysis of covariance was performed for each of the following:

(a) Post-test scores, Program 7, IQ and reading comprehension as control variables (4 groups)

(b) Post-test scores, Program 7, IQ and pre-test scores as control variables (4 groups)

(c) Retention scores, Program 7, IQ and reading comprehension as control variables (4 groups)

(d) Retention scores, Program 7, IQ and pre-test scores as control variables (4 groups)

(e) Pre-test scores, Program 7, IQ and reading comprehension as control variables (4 groups)

(f) Post-test scores minus retention scores, Program 7, IQ and pre-test scores as control variables (4 groups)

(g) Post-test scores, Program 6, IQ and pre-test scores as control variables (Gr. I vs III)

(h) Post-test scores, Program 4, IQ and pre-test scores as control variables (Gr. I vs II)

(i) Post-test scores, IQ below median, Program 7, pre-test and reading comprehension as control variables

(j) Post-test scores, IQ above median, Program 7, pre-test and reading comprehension as control variables.

None of the ten analyses resulted in an *F* which approached or reached significance at the .05 level of confidence. With this age group and with the programs used, no evidence of inter-class learning sets as a function of experience with 2 programs, 4 programs, or six programs was found.

3. Comparison by Sex

Analyses of covariance were performed for males and for females, all four groups, on post-test scores for Program 7 and for the retention scores, with IQ and pre-test scores as control variables. Again, no *F* approached significance at the .05 level of confidence.

DISCUSSION

1. Intra-class Learning Sets

Gagné's (1962) finding that there may be a hierarchy of learning sets to be acquired within a specific learning program was not in question in this study; in fact, it was set as a condition for each of the programmed units selected for inclusion in the study with

the college population and in the study with the sixth-grade population. As a check on our intuitive analysis of the programs used with Grade 6, a comparison was made of errors on criterion items for the first portion of a unit with errors on the criterion items for the last portion of a unit for a group which was exposed to the program versus a control group which was not exposed to the program (Table 8). The data in Table 8 represent more than exposure versus no exposure to a unit of programmed instruction; they indicate that the material in each programmed unit tended to be sequential. As a consequence, the differences in errors between groups on the last ten items on the six programs for which comparisons were made are two or three times as great as the differences in errors between groups on the first ten items.

The data are not construed as direct support for the concept of intra-class LA; rather, they provide support for the sequential nature of the material and the notion that minimal mastery of the end of a sequence is dependent upon some mastery of the earlier segments or levels of a class of tasks. Ideally, Group IV, the control, should have produced an error rate on the last ten criterion items of ninety per cent or more while Group I, the exposed group, should have produced an error rate approximating zero.

2. Inter-class Learning Sets

(a) Gain scores

For the college population, the variable of number of previous programs was significantly related to achievement (see pp. 15 and 16) as measured by post-test minus pre-test scores ($p < .001$). Tentatively, the learning set appeared to be formed during experience with the first three programs regardless of the order in which the

programs were presented and regardless of the subject matter of the program. Further, experience with three additional programs tended to have a slightly negative effect on achievement as represented by gain scores.[1]

For the sixth grade population, number of previous programs was not found to be related to achievement (Table 9), a result which accords with the findings of Reynold and Glazer (1962, 1964) for three topics in general science used with a junior high school population. None of the data in Table 9 provides any evidence of transfer of training in the traditional sense. Further, no evidence was found that the number of previous programs experienced affected retention of the material learned from the seventh and last program used.

(b) Error rate

For the college population, the variable of number of previous programs was significantly related to error rate ($p < .01$) although as noted (see pp. 16 and 17), the effect is really negative after completion of three programs.

(c) Discrepancy between studies

Since the subject matter of the programs and the experimental designs differed in the two studies, one cannot conclude from the data presented that learning sets for continuous discourse material are demonstrable in a college population but not in an elementary school population. There are no obvious reasons for the discrepancy in findings beyond the two mentioned. In fact, one would expect

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[1] Detailed computer analysis of the data on the effects of number of programs have been undertaken and it is expected that a supplemental report of the results will be issued. Meanwhile, these two findings must be considered to be tentative. (See p. 17, note on equations.)

that, if learning sets were formed at all, they would be more likely to occur in the younger, i.e. the less experienced group rather than in the sophisticated learners one finds in a college population.

If the same findings were to result from a replication of Study One on two age groups, it is likely that an interpretation would have to be cast in the language of motivation and attitude formation rather than in the language of cognitive psychology. For example, the programmed material, particularly in the context in which it was used, was probably much more novel for the college Ss than for the sixth grade Ss. The latter group worked in their regular classrooms in the presence of their regular teachers on subject matter which probably was perceived as related to that typically presented at this grade level. The college Ss worked in a "laboratory" under supervision of proctors ("strangers") on material which, in the main, was unrelated to the course in which they were enrolled. Further, for college Ss, a program differs more from the instructional materials used typically than it does for elementary school children who are accustomed to workbooks, printed handouts, "seat" work, etc. If this was the case, it might be hypothesized that the college Ss' initial responses to the novel situation were strongly positive while those of the sixth-grade Ss tended toward neutrality or "more of the same." By the beginning of the fourth week, hence, of the fourth program, college Ss shifted toward the "more of the same" position. Many experimenters have noted the development of negative attitudes toward programmed material after several hours of experience with it. In sum, it is suggested that inter-class learning sets, when established, are largely motivational and attitudinal.

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APPENDIX A

Instructions for College Population

1. You will find three booklets in front of you. Turn over the top booklet. It should have a number followed by the letter "A" at the top.

2. Place you FULL name at the top right hand corner. Do not be discouraged if most of the information is new to you. You may write your answers on the test. DO NOT GUESS. When you finish, turn the test over and wait for further instructions. BEGIN!

3. Take one of the answer sheets and write you full name at the top. Turn over the thick booklet and place the number at the top of the booklet on the answer sheet in the appropriate place. Open your booklets to item or frame number 1. You will notice that item 1 contains some information and is accompanied by a question. The answer to that question follows the item. In booklet 4, however, you will notice that the items appear horizontally, item 2 is on the following page and item 3 on the next page, etc. In booklet 3 the answers appear to the left of the item in the margin.

4. Take the answer sheet and cover the page which contains number 1; this is done to conceal the answers until you have read the question. For program 4 this is not necessary since the answer appears on the next page preceding the next question. For programs 1, 2, 3, you can conceal the answers by using the mask which you will find on your desk.

5. At the right of your answer sheet mark number 1. This is the first sheet which you will be using. If you need another answer sheet, mark it number 2, the next number 3, etc. The answer sheet is divided in half, each half is identical. When you have used all of the first half, you may proceed to the top of the second half.

6. Slide your answer sheet down until only item 1 is revealed. The answer should be concealed either by the answer sheet, mask or on another page. Read item 1 and write in the column at the left on your answer sheet number 1. Under the column marked answer, write what you consider to be the correct answer to item 1. Slide the answer sheet down or move the mask or turn the page to reveal the correct answer to that question. Now you can compare your answer with the correct answer. If you have made an error place a check mark in the column marked "check if error."

7. You will not be penalized for a wrong answer. We have found that the best way to use programmed materials is to keep the correct answer concealed until you have worked the problem.

8. When you have completed item 1 and checked your answer, move on to item 2 being careful not to see the correct answer. You may establish your own working pace, work as rapidly and accurately as you can. The booklets will be collected in approximately 90 minutes.

9. Should you finish before this time, turn your booklet over and wait for further instructions. Be certain that you make a check mark when you make an error; once again, you will not be penalized for errors. Take the last booklet on your desk and turn it over. Place your full name in the upper right hand corner. This is a test. You may answer the questions on the test. You have 15 minutes. BEGIN.

APPENDIX C

College Population Criterion Tests

CHINESE HISTORY

____ 1. Prior to the period of imperialistic advances by the West, China advocated a policy of
a. limited trade agreements
b. trade agreements with the most favored nations
c. no trade agreements
d. cultural isolation with limited trade agreements

____ 2. The date which best approximates the beginning of western imperialism in China is
a. 1750
b. 1800
c. 1850
d. 1900

____ 3. Which Treaty ended the Opium Wars?
a. Treaty of Versailles
b. Treaty of Taiping
c. Treaty of Nanking
d. "Une qual" Treaty

____ 4. The first western nation to gain commercial concessions from China was
a. England
b. Germany
c. Russia
d. The United States

____ 5. The country which held the greatest interests in China during the imperalistic period was
a. England
b. Germany
c. Russia
d. The United States

____ 6. Select the <u>two</u> internal events which contributed most to the weaken-
and ing of China.
____ 7. a. Boxer Rebellion
b. Peasant Revolts
c. Opium Wars
d. Reactionary Rulers
e. Decline of the dynasty
f. Open Door Note
g. Trade Concessions

____ 8. In the last decade of the nineteenth century China made an attempt to oust their western enemies. This attempt was the
a. Taiping Rebellion
b. Opium War
c. Boxer Rebellion
d. Open Door Note
e. Sino-Japenese War

____ 9. Which of the following insured equal trade opportunity for all nations in China?
a. Open Door Note
b. Most Favored Nation Policy
c. Treaty of Versailles
d. Treaty concluding the Opium War
e. Decline of the dynasty

____ 10. During the period of western imperialism, one western nation proposed a plan to maintain the territorial integrity of China. This plan was successful because of the support it received from a second nation. This plan was called the
a. Balance of Power Plan
b. The Spheres of Interest Plan
c. Open Door Note
d. Most Favored Nation Plan

____ 11. The country that initiated this plan was
a. England
b. Germany
c. Russia
d. The United States

____ 12. The country that initiated this plan was motivated by a desire to
a. establish missionary settlements and restore good will
b. protect her own interests in China
c. establish some trade concessions for herself
d. prevent the annexation of Chinese territories by other Western nations

____ 13. The second nation that supported this plan was
a. England
b. Germany
c. Russia
d. The United States

____ 14. This second nation was motivated by a desire to
a. establish missionary settlements and restore good will
b. protect her own interests in China
c. establish some trade concessions for herself
d. prevent the annexation of Chinese territories by other western nations

____ 15. The countries which profited most from the Sino-Japanese War were
a. England, Russia and Germany
b. England and the United States
c. England, United States and Germany
d. Germany, Russia and the United States

____ 16. We associate the phrase "too little and too late" with the
a. decline of the dynasty
b. peasant revolts
c. Boxer Rebellion
d. Dynastic reforms
e. Trade Concessions

____ 17. Following the collapse of the dynasty, the unifying force in China
and was nationalism. Select the <u>four</u> events which contributed to the
____ 18. growth of this force.
and a. Sino-Japanese War
____ 19. b. Russo-Japanese War
and c. Opium War
____ 20. d. Versailles Treaty
e. Nanking Treaty
f. Taiping Rebellion
g. Boxer Rebellion
h. Industrial Revolution
i. Restricted immigration to U.S.
j. Peasant Revolts

____ 21. The date which best approximates the rise of nationalism in China is
a. 1800
b. 1850
c. 1900
d. 1950

____ 22. We associate the phrase "return to the past" with the
  a. Open Door Note
  b. Boxer rebellion
  c. Dynastic reforms
  d. Nationalism
  e. Taiping Rebellion

____ 23. The nationalistic movement in China
  a. met with early success
  b. failed to unify China
  c. was successful because of the many peasant revolts
  d. was reactionary in nature

____ 24. The Boxer Rebellion
  a. was supported by the dynasty
  b. was successful because of its widespread popularity with the peasants
  c. was a plan to overthrow the dynasty
  d. was the most famous of the peasant revolts

25. The leader of the nationalistic movement in China was _____.

26. The dynasty which ruled China during the period of western imperialism was the _____.

27. The western nations never annexed their holdings in China because each was afraid of upsetting the _____.

28. The areas in China held but not annexed by the western nations were called _____.

____ 29. During the period of imperialistic demands by the west the Chinese
and dynasty was rocked to its foundation by a series of events. Select the five events which greatly weakened the dynasty during this period.
____ 30.
and
____ 31.
and
____ 32.
and
____33.

  a. Sino-Japanese War
  b. Concessions to the western nations
  c. suppression of reform by dynasty
  d. peasant revolts
  e. restricted immigration to U.S.
  f. Taiping Rebellion
  g. Failure of the Boxer rebellion
  h. Russo-Japanese War fought on Chinese soil
  i. Versailles Treaty
  j. Nanking Treaty

SYMBOLIC LOGIC

Matching:

_____	1. A	A. Sentence variable
_____	2. Formalize	B. Connecting word
_____	3. Q	C. "It is false that"
_____	4. K	D. Isolation of a logical form
_____	5. Representation (do not use F.)	E. "and"
_____	6. N	F. Representation of a sentence
_____	7. r	G. Content and form
_____	8. KPQ	H. "or"
_____	9. C	I. "If. . . .then"
		J. Elementary sentence

Give a correct representation of the following sentences: If one letter is needed to make a representation, use Q, if two letters are needed, use Q and R.

_____ 10. Aristotle admired Plato's work

_____ 11. R and Q

_____ 12. If Plato taught Aristotle, then Plato deserves praise.

_____ 13. If R then P

_____ 14. Socrates was very wise, or Socrates was very wise.

_____ 15. It is false that Q

_____ 16. Plato founded the Academy, or Plato at least taught in the Academy.

_____ 17. Q or P

_____ 18. Socrates was learned, and Socrates was wise.

_____ 19. ARQ

_____ 20. It is false that Athens put Aristotle to death.

List the five sentence variables.

_____ 21.

_____ 22.

_____ 23.

_____ 24.

_____ 25.

Formalize the following: (Use any sentence variables you wish.)

_____ 26. It is false that the Athenian Government put Aristotle to death.

_____ 27. KPQ

_____ 28. NP

_____ 29. Aristotle was born in 384 B.C., and Aristotle died in 322 B.C.

_____ 30. R

_____ 31. Aristotle taught Socrates logic.

_____ 32. ATT

_____ 33. Socrates drank hmelock, or Socrates drank hemlock.

_____ 34. ASR

_____ 35. If Athens had put Aristotle to death, then Athens would have killed two great philosophers.

FEDERAL RELATIONS TO EDUCATION

DIRECTIONS: For the multiple choice items below, select the item which you consider the best or most complete answer.

____ 1. In practice, the American Constitution consists of:
   a. the written document and its amendments
   b. the written document, amendments and unwritten practice
   c. the written document and amendments as interpreted by government officials.
   d. both b and c
   e. both a and c

____ 2. The United States Constitution makes specific provisions for education in:
   a. the general welfare clause
   b. the preamble
   c. the 19th amendment
   d. all of the above
   e. none of the above

____ 3. Positive powers of the Federal Government regarding education are:
   a. delegated by the Constitution
   b. implied from Article I, Sec. 8, of the Constitution
   c. inherent in federal sovereignty
   d. contained in the Bill of Rights

____ 4. Article 1, Section 10, of the Constitution
   a. restricts state power regarding ex-post-facto laws and contracts
   b. enlarges state power regarding ex-post-facto laws and contracts
   c. restricts both state and federal powers in the two areas mentioned above
   d. restricts state and federal power regarding contracts only

____ 5. The general welfare clause of the Constitution
   a. extends the power of the Federal Government
   b. restricts state power
   c. both a and b
   d. has had little effect on Congress

____ 6. Education cases involving freedoms of speech or religion are heard under provisions of the
   a. 5th amendment
   b. 1st amendment
   c. the 10th amendment
   d. the equal protection clause

____ 7. One who is a strong advocate of states rights would frequently refer to
   a. Article I, Section 10
   b. the 5th Amendment
   c. the 10th Amendment
   d. the 1st Amendment

____ 8. A citizen who had been denied due process of law by a Federal agency would appeal to the courts under provisions of:
   a. the 14th Amendment
   b. the 14th and 1st Amendments
   c. the 1st and 5th Amendments
   d. the 5th Amendment

____ 9. State interference with judicial rights and due process of law would be considered by the courts under provisions of
   a. the 14th Amendment
   b. the 10th Amendment
   c. the 5th Amendment
   d. both the 14th and 5th Amendments

____ 10. The equal protection clause and the due process clause as they affect the states are found in
a. the 5th Amendment
b. the 14th Amendment
c. both of the above
d. neither of the above

____ 11. A citizen of the District of Columbia denied due process of law there would appeal to the courts under
a. the 14th Amendment
b. the 14th and 1st Amendments
c. the 1st and 5th Amendments
d. the 5th Amendment

____ 12. The general welfare clause usually referred to in court cases is found in
a. the Preamble
b. Article I, Section 8
c. Article I, Section 10
d. Both a and b
e. Both a and c

____ 13. The Supreme Court will give an opinion regarding a Constitutional question
a. at the request of the President
b. at the request of Congress
c. if required in a case decision
d. all of the above
e. none of the above

____ 14. A strict interpretation of the general welfare clause was advocated by
a. Hamilton
b. Jefferson
c. Washington
d. Madison

____ 15. The power of the courts to determine the constitutionality or unconstitutionality of legislative and executive actions is known as:
a. a plenary power
b. judicial review
c. a mandamus action
d. a constitutional power

____ 16. In carrying out their governmental responsibilities, the Constitution is interpreted by officers of
a. the Executive Branch
b. the Legislative Branch
c. the Judicial Branch
d. all of the above
e. none of the above

____ 17. In U. S. v. Butler, the specific point at issue was
a. the interpretation of the general welfare clause
b. the constitutionality of the Agricultural Adjustment Act.
c. legislative powers over agriculture and industry
d. federal assistance to agricultural education

____ 18. U. S. v. Butler is an important case for education because
a. the constitutionality of the Social Security Act was upheld
b. the area of powers reserved to the states was defined
c. the general welfare clause was interpreted according to Hamilton's viewpoint
d. the Agricultural Adjustment Act was declared constitutional

____ 19. An Act of Congress affecting the education function of the various states would be considered unconstitutional if
a. it used Federal taxes to induce state cooperation
b. it primarily served to regulate some aspect of education
c. both a and b
d. regulation entered the Act in any way

____ 20. Helvering v. Davis is an important case for education because
a. the Social Security Act was held to be consitutional
b. Congress' power to tax for social welfare legislation was upheld
c. the general welfare clause was interpreted broadly as giving Congress power to assist the states and secure their cooperation in projects of national concern
d. federal aid to education was not questioned

____ 21. Which of the following are unwritten governmental practices that have become part of our Constitution?
a. power of judicial review
b. a president's cabinet
c. laying and collecting of taxes
d. both a and b
e. both b and c

____ 22. If a business concern was suddenly required to pay state taxes on all its products sold since 1962, it could appeal to the provision in Article 1, Section 10, which
a. impairs the obligation of contracts
b. restricts state power in passing ex-post-facto laws
c. provides for a general interpretation of the general welfare clause
d. provides monetary compensation in such cases of emergency

____ 23. In which of the following ways do the British and American governments differ?
a. The British system divides the power between the national government and the various sub-states.
b. the British Constitution has never been written into a single document providing a basic framework of government.
c. the entire American constitution as practiced is written into a single document and contains no unwritten practices.
d. the American system alone has "bills of rights" guaranteeing personal liberties.

____ 24. The Bill of Rights was added to the American Constitution to
a. restrict federal power
b. permit the federal government to lay and collect taxes
c. protect personal liberties
d. both a and c

____ 25. Which of the following represents a judicial right of the individual protected by the 5th Amendment?
a. protection against self-incrimination
b. the right to claim income tax deductions
c. freedom of speech
d. the right to make a citizen's arrest

____ 26. To provide an impartial trial under established rules when life, liberty or property are at stake, is specifically the aim of
a. the ex-post-facto law
b. the 1st Amendment
c. due process of law
d. the general welfare clause

____ 27. Which Amendment emphasizes the division of powers between the federal government and the states?
a. fifth
b. tenth
c. first
d. fourteenth

____ 28. Match the following amendments with the words with which they are associated.

(a)	fifth _____	(1)	reserved powers
(b)	first _____	(2)	due process of law
(c)	tenth _____	(3)	freedom of speech and religion

____ 29. Which clause restricts the powers of the states in denying educational rights to Negroes because of their color?
a. contract clause
b. general welfare clause
c. due process clause
d. equal protection clause

____ 30. Before the Supreme Court will interpret provisions of the Constitution the dispute must
a. involve legislation of national concern
b. take the form of a court case
c. be submitted by the President's cabinet
d. concern the Bill of Rights

PROGRAMMING

_____ 1. The pioneer who saw uses for mechanical devices in the classroom was _____.

_____ 2. These early mechanical devices were used primarily for
a. testing
b. teaching
c. practice work

_____ 3. In a good program the writer gradually reduces the amount of assistance he gives the student. This process is called _____.

Consider the following:
Program A teaches a concept in 25 steps. Program B teaches that same concept in 20 steps. Program C teaches that same concept in 10 steps. At the close of the program it was found that students do equally well on an achievement test regardless of which program they used. The following three questions pertain to this information.

_____ 4. Which program is most efficient?

_____ 5. Which program is most effective?

_____ 6. Which program would most likely make the greatest allowance for individual differences?

_____ 7. The man who played the most important role in the development of programmed teaching techniques is _____.

_____ 8. If the material you have been exposed to prior to this test were placed in a special binding or cover we would call it a _____.

Consider the following:
In ordinary English "reinforce" is a synonym of "strength". Something that strengthens behavior can be said, then, to "_____" the behavior.
The following six questions pertain to this information.

_____ 9. The above piece of information is a part of a large sequence of material. The name given to this technique of teaching is _____ _____.

_____ 10. This single piece of information is called a _____.

_____ 11. In order to assist the student the writer has associated the words "strengthen" and "reinforce". This assistance by the writer is called _____:

_____ 12. The goal of the writer is to have the student respond with "reinforce" when no assistance is given. The writer has defined this goal as the _____ behavior.

_____ 13. In a program such as the one above the amount of material covered by the student is controlled by the
a. program writer
b. student
c. teacher

_____ 14. A program similar to the one above accommodates individual differences by allowing the student to
a. work at his own rate of speed
b. skip material he already knows or review difficult areas
c. always make the correct response

Consider the following:
Jim, a bright student, finds that in using Program A he may bypass certain information that he already knows. Jack, a slow student, also using Program A finds that he must frequently return to review sections.
The following four questions pertain to this information.

_____ 15. The students are going through material written in a _____ sequence.

_____ 16. This material is characterized by
a. completion questions
b. matching questions
c. multiple-choice questions

_____ 17. In a program such as the one above the amount of material covered by the student is controlled by the
a. program writer
b. student
c. teacher

_____ 18. A program similar to the one above accommodates individual differences by allowing the student to
a. set his own pace
b. cover areas in the program that meets his needs
c. always make the correct response

_____ 19. Which teacher makes the best use of reinforcement?
a. the teacher who gives a test and has the students exchange papers following the exam to make corrections
b. the teacher who reads a test question and then writes the correct answer on the blackboard
c. the teacher who gives a test and returns the corrected papers the next day

_____ 20. A student responds to a question in a program. He then checks his answer with the correct answer. The type of reinforcement that takes place if his answer is correct is called _____.

Place the following in their correct temporal order using the letters only.

_____ 21. a. response-correct
_____ 22. b. information
_____ 23. c. reinforcement
_____ 24. d. confirmation
_____ 25. e. assistance by the writer
_____ 26. f. question

_____ 27. If the consequence of a response makes that response more likely to occur again, the consequence, then, can be said to _____ that response.

There are three factors which combine to make a good program. List these three factors.

28. _____

29. _____

30. _____

RUSSIAN VOCABULARY

1. Write the English meaning for the following Russian words:
   (a) dobryoyeh _____
   (b) ootro _____

2. Select the English word which has the sound most like the Russian "O". Write the word at the right.
   coat cop _____

3. Write the Russian letter which best describes the sound of the following English letters:
   (a) S _____
   (b) R _____
   (c) d _____
   (d) ee _____
   (e) B _____

4. Write the Russian words that mean the same as the following English words:
   (a) Thanks _____
   (b) friend or comrade _____

5. Write the English letter or combination of letters which best describes the sound of the Russian "a". _____

6. Which English word has the sound most like the Russian "a".
   land law _____

7. Write the English words which sound like the following Russian words:
   (a) НУС _____
   (b) РУМ _____
   (c) КОСТ _____
   (d) ТРАНС _____
   (e) МАРУН _____
   (f) МУВ _____
   (g) КАб _____
   (h) РОД _____

8. Write the English letter or combination of letters which best describes the sound of the Russian "O". _____

9. Give the English letter or combination of letters which best describes the sounds of the following Russian letters:
   (a) H _____
   (b) K _____
   (c) Y _____
   (d) V _____

10. Give the Russian spelling "in sounds" of the following English words:
    (a) rock _____
    (b) scan _____
    (c) toot _____
    (d) draw _____
    (e) bee _____
    (f) doom _____
    (g) mood _____
    (h) rod _____
    (i) soon _____

SET THEORY

1. Use the listing method to write the following:

   a. the set containing the whole numbers 1, 6, 11, and 16.

   _____

   b. A is the set containing the numbers 10, 20, 30 and 50.

   _____

   c. X is the set of odd whole numbers from 1 to 17,000,001.

   _____

2. Write the symbols for:

   a. is an element of _____

   b. the continuation of a sequence of numbers _____

   c. is not equal to _____

   d. empty or null set _____

3. Given:

   $A = \{5, 10, 15. . . . .100\}$

   $B = \{2, 4, 6. . . . . 60\}$

   $C = \{4, 8, 12. . . . .60\}$

   Tell whether these statements are true or false.

   a. $35 \in A$ _____

   b. $35 \in A$ and B _____

   c. $16 \in C$ _____

   d. $A = B$ _____

   e. A is an infinite set _____

4. Write the symbols for:

   a. is not an element of _____

   b. the set containing _____

   c. belongs to _____

   d. equal to _____

5. Given:

A = {1,3,5,7,9,11} D = { }

B = {3,7,11,9,3,3,5} E = {3,1,3}

C = {1,3} F = {1,2,3. . . .}

Answer the following:

a. How many members in set B? _____

b. How many members in set D? _____

c. List the sets (by letters) which are finite sets. _____

d. List the two equal sets. _____

Tell whether these statements are true or false:

e. $0 \in D$ _____

f. $4.5 \notin F$ _____

g. $.6 \in D$ _____

h. B has more members than A _____

6. Write in symbols:

a. B is the set of numbers, divisible by 3, from 12 to 24 inclusive. _____

b. P is the set of prime numbers less than 1. _____

c. R is the set of numbers, divisible by 1000, beginning with 10,000. _____

7. Decide whether or not these pairs of sets are equal. If they are equal write equal; if they are not equal write not equal.

a. A = {10, 10½, 11, 11½, 12} B = {10, 10½, 11. . . .12½} _____

b. A = {5, 10, 15. . .75} B = {5, 10, 15. . . .} _____

c. A = {6, 7, 8, 4, 3, 2, 1} B = {1, 2, 3. . . . .8} _____

d. A = {0} B = $\emptyset$ _____

	Gain		Error rate	
Constant	Coefficient	t	Coefficient	t
	17.14	-	7.65	-
x_1: Sex: 1 = male; 0 = female	1.58	-3.50	1.28	2.08
x_2: GPA: Actual value	.98	3.13	-.18	-.42
x_3: Instructor: 1 = G; 0 = T	.06	.12	1.64	2.56
x_4: Test 1: 1 if test 1; -1 if test 6; 0 otherwise	-2.30	-5.52	7.43	13.07
x_5: Test 2: 1 if test 2; -1 if test 6; 0 otherwise	2.79	6.71	-6.91	-12.17
x_6: Test 3: 1 if test 3; -1 if test 6; 0 otherwise	-.99	-2.73	2.29	4.58
x_7: Test 4: 1 if test 4; -1 if test 6; 0 otherwise	-5.35	-12.61	.69	1.15
x_8: Test 5: 1 if test 5; -1 if test 6; 0 otherwise	7.91	21.67	-1.30	-2.61
x_9: No. of previous tests	1.02	3.49	1.15	2.89
x_{10}: (No. of previous tests)^2	-.14	-2.10	-.40	-4.36

Variables, Coefficients and t Values for the Linear Models

APPENDIX D

APPENDIX E

Sixth Grade - Instructions and Criterion Tests

TO THE STUDENT

Each of you is going to help us with some new books called programs which we are writing. We believe that these books or programs will help you to learn better than any book which you had to study before. As you will see, the programs are different from any books which you have ever seen and you will work with them in a different way than you work with books.

There will be a folder with your name and your group number on it which your teacher will have. When it is time for you to work with this material you will get your folder from the box and take it to your desk. When you open the folder, you will find that one side of it will be labeled "Week 1" and the other side, "Week 2." There will be directions for you to follow for each week's work. IT IS IMPORTANT FOR YOU TO DO THE WORK IN THE CORRECT ORDER. That means that you do the work in the left side of your folder during one week and the work in the right side of your folder during the second week.

Please follow the directions carefully and exactly. If you do not know what to do, ask your teacher to explain it to you. PUT YOUR NAME ON EVERY TEST AND EVERY PROGRAM IN THE FOLDER.

We know that you will do your best to learn as much as you can.

Thank you for your help.

1. Take the test out of the folder. You will find it right behind this sheet of directions.

2. Leave everything else in the folder.

3. Write your first and last name on the top of the first page of the test.

4. Answer as many of the questions as you can. You will not know any of the answers sometimes! If you don't know them, don't be discouraged. Just do the best that you can.

5. When you have finished with the test, put it in the folder on the same side where you found it, BUT put it back of the other papers on that side.

6. Next Then, take the program from the folder. Read the paper which tells you how to work on it.

1. Take the test out of the folder. You will find it right behind this sheet of directions.

2. Leave everything else in the folder.

3. Write your first and last name on the top of the first page of the test.

4. Answer as many of the questions as you can. You will not know any of the answers sometimes! If you don't know them, don't be discouraged. Just do the best that you can.

5. When you have finished with the test, put it in the folder on the same side where you found it, BUT put it back of the other papers on that side.

6. Next You have no other work to do in this folder until Friday. On Friday, remove the second test from the folder, put your name on it, and answer as many questions as you can. When you have answered all of the questions which you can, put the test back in the folder on the same side.

HOW TO USE THIS PROGRAM

1. Write your first and last name at the top of the first page of the program.

2. When you work with a program, always use the card which you will find in your folder to cover the answers on the page. Now, put your card underneath the first question on the page.

3. Read the question carefully.

4. Write your answer to the question on the line or in the blank space beside the question.

5. Now move your card down the page until it is under question 2. Compare your answer to Question 1 with the right answer given you on the side of the page. Do not change your answer if it is wrong.

6. Read Question 2 carefully and write your answer to it. Move your card down the page until it is under Question 3. Compare your answer to Question 2 with the right answer to Question 2.

7. Each time after you have written an answer, you should slide your mask downward to find out whether you have written the correct _____.

   answer, word, response (any of these is correct)

8. Sometimes you will be given a clue to the correct answer. Watch for words in italics, like the one in the first line. The words in italics will usually give you a _____ to the correct answer.

   clue

9. Write the answer to every question. If you don't know the answer, guess!

10. Often when a number is required for the answer, you will see this (number) following the answer line. There are now _____ (number) states in the United States.

    50

11. Sometimes a letter will suggest the answer to you. Here is an example:

    When a newborn baby is expected, the parents usually wonder whether it will be a boy or a g_____.

    girl

12. Sometimes you will be given a choice between two answers. For example, you have been instructed to write every answer because the act of writing in answers has been found important to learning. If you read through the book writing in some answers and filling in others mentally, you will only _____ (hinder/help) your progress. hinder

13. It is very important that you actually write the answer. And be sure to write your answer before looking at the answer given in the answer column. It is very important that you actually _____ out each answer.

14. You now are ready to begin work with the program.

15. Each time that you work with the program, look at the clock and write the time when you start and the time when you stop. You can write this at the top of the first page of the program. Write it now.

    You won't finish today, so each day when you work on the program, put down the time when you start and when you stop.

16. At the end of the week after you have finished with the program, you will take the second test to find out how much you have learned.

Music

1. Draw (1) a whole note, (2) a half note and (3) a quarter note.

2. Draw (1) an eighth note and (2) a sixteenth note.

3. Draw a staff and show a time signature of $\frac{2}{4}$.

4. Draw a staff and show four bar lines.

5. Draw a staff and show that the half note will receive one beat and that there will be four beats in every measure.

6. Draw a staff and show each of the following (1) a whole rest (2) a half rest and (3) a quarter rest. Number them (1), (2), and (3).

7. Draw a staff and show (1) an eighth rest and (2) a dotted half note. Number them (1) and (2).

8. Draw a staff and show whole notes in (1) the fifth line (2) the second line (3) the first space and (4) the third space. Number them (1), (2), (3), and (4).

9. Draw a staff and show the two clef signs. Label them with their correct names.

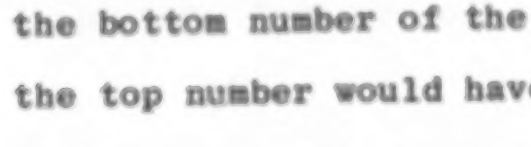
10. If in a certain song this type note is worth two beats, then is worth (1) _____ beat(s) and is worth (2) _____ beat(s).

11. Suppose in another song is worth two beats, then (1) _____ is worth four beats and (2) ____ is worth eight beats.

12. In order to determine what kind of note receives one beat, we look at the (1) _____ _____ of the time signature. The (2) _____ _____ of the time signature tells us how many beats there are in each measure.

13. With the time signature $\frac{3}{4}$, we know that the (1) _____ note is to receive one beat. Then we know that that (2) _____ note is to receive four beats and the (3) _____ note is to receive two beats.

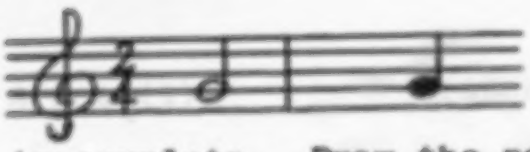
14. The spaces between the bar lines are called _____.

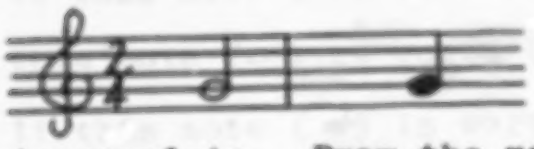
15.  If you are told that the bottom number of the time signature is two, the top number would have to be _____.

16. If you are told that the bottom number of the time signature is four, the top number would have to be _____.

17. The rests indicate a _____ instead of a sound as called for by notes.

18. Suppose you have a time signature of $\frac{3}{4}$. The whole rest is worth (1) _____ beats; the half rest is worth (2) _____ beats; the quarter rest is worth (3) _____ beats.

19.  The first measure is complete. Draw the note which could be used to complete the second measure.

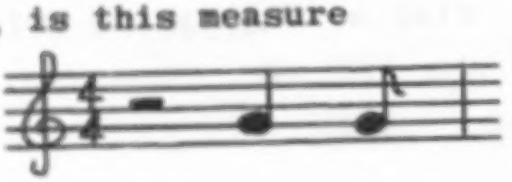
20.  The first measure is complete. Draw the rest which could be used to complete the second measure.

21. Draw one note which is equal in value to the following set of notes.

- (1) _____

- (2) _____

- (3) _____

22. With this time signature, is this measure complete? (yes or no) 

23. "Beam" these notes together

- (1) _____

- (2) _____

- (3) _____

- (4) _____

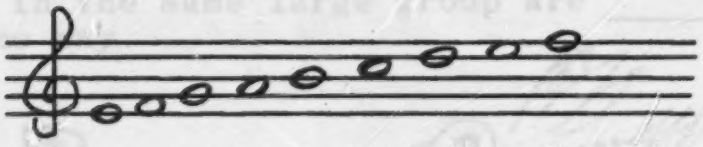
24. When you see this sign , you treat it as though the numbers _____ were there.

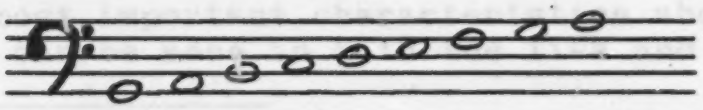
25. When you see this sign , you treat it as though the numbers _____ were there.

26. This time signature () indicates a(n) (1)_____ note receives one beat. This time signature () indicates a(n) (2)_____ note receives one beat.

27. A dot (1) _____ (increases or decreases) the value of the note by (2) _____.

28. If this note (𝅝) is worth four beats, then this note (𝅝.) is worth (1) _____ beats.
If this note (𝅗𝅥.) is worth three beats, then this note (𝅗𝅥) is worth (2) _____ beats.

29.  Write the letter names for these notes starting from left and going right.

30.  Write the letter names for these notes starting from left and going right.

MAMMALS

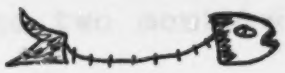
1. Scientists have grouped all animals that are _____ together.

2. When we put animals into groups, we are said to _____ them.

3. If two animals both have backbones and both bear their young live, we say that having backbones and bearing live young are their _____ _____.

4. The largest classes into which animals may be grouped are called _____.

5. All animals in the same large group are _____ to each other in some way.

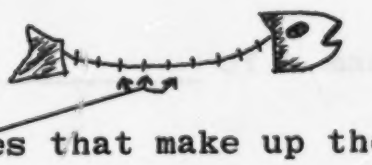


6. One of the most important characteristics about which animals are grouped can be seen in both the fish and the bird, named a _____.

7. The name of the phylum that includes all animals with the characteristic mentioned in question 6 is _____.

8. (1) Would people be included in the phylum in question 7? (yes or no)
   (2) Would snakes? (yes or no)

9. A snail does not have a (1) _____ and therefore cannot be included in phylum (2) _____.



10. The smaller bones that make up the (1) _____ are called (2) _____.

11. When the animals in a phylum are studied, we find that certain animals have common _____ that other animals do not have.

12. The scientist then groups animals which are more closely related into groups called _____.

13. Birds and bears are in the same (1) _____, but not in the same (2) _____.

14. Snakes and people are not in the same (1) _____ but, they are in the same (2) _____.

15. The most intelligent members can be found in the _____ class.

16. In the class mentioned in question 15, all of the animals are nearly the same size. (yes or no)

17. In this class, all the animals must have five toes. (yes or no)

18. In this class, most of the animals have hair on their bodies. (yes or no)

19. Another important characteristic of this class is the way they have babies or what scientists call _____.

20. The babies of almost all the animals in this class are _____.

21. Name two members of this class who lay eggs.

22. The glands of the females in this class which manufacture milk are called _____ glands.

23. The members of this class also have (1) _____ through which they breath (2) _____.

24. Name one member of this class which spend its life in the water, but breaths in the same manner as the other members.

25. Still another characteristic of this class is that they are "warm-blooded." (yes or no)

26. When we say that an animal is (1) _____ (warm or blue) blooded we are really talking about its body (2) _____.

27. The body (1) _____ of a mammal remains (2) _____.

28. The only (1) _____ (warm or blue) blooded animals are (2) _____ and (3) _____.

29. A snake's body temperature does not change so we say a snake is _____ _____.

30. The body temperature of a mammal does not depend on the temperature of its _____.

WEATHER

_____ 1. To tell what the weather will be before it happens is to _____ the weather.

_____ 2. People who depend on the out-of-doors for earning a living are very interested in the _____.

_____ 3. The clouds which look like horsetails are called _____ clouds.

_____ 4. A change in the weather is known as an advancing weather _____.

_____ 5. The clouds which are flat and not very pretty are called _____ clouds.

_____ 6. The thick clouds that make our darkest days are called _____ clouds.

_____ 7. _____ clouds are made up of tiny bits of ice and are the first sign of a coming weather change.

_____ 8. When a storm comes so close that we know we will have rain or snow, we can see the _____ clouds.

_____ 9. The clouds in question 7 are followed by those in question 8 and finally the _____ clouds bring the rain.

_____ 10. When stratus clouds come so close to the ground that we are in them, it is called _____.

_____ 11. A coming change in the weather can best be predicted at (1) _____ or at (2) _____.

_____

_____ 12. In North America weather usually moves from (1) _____ to (2) _____.

_____

_____ 13. Usually if we see a beautiful sunset, the next day will be _____. rainy fair cloudy warmer

_____ 14. When we see cumulus clouds with a dark center, and then see lightning and hear thunder, we are looking at a _____.

_____ 15. A wind _____ usually comes with the lightening, thunder, and rain of the storm mentioned in question 14.

_____ 16. A thunderhead is made up of (1) _____ clouds and (2) _____ clouds.

_____

_____ 17. A thunderhead usually brings a (long or short) storm.

_____ 18. The prefix alto as in altocumulus clouds means _____.

_____ 19. When we have altocumulus clouds, we are said to have a _____ sky.

_____ 20. Those clouds which are in rows of columns like the scales of a fish are _____ clouds.

_____ 21. The technical name for a thunderhead is _____.

_____ 22. Weather men try to _____ the weather, but they are not always correct.

_____ 23. The cirrus clouds are the highest clouds that we see. (yes or no)

_____ 24. The stratus clouds are light and airy and never hide the sun for long. (yes or no)

_____ 25. We see nimbus clouds only after a storm has passed and the sun has come out. (yes or no)

_____ 26. On a fair day we can see the big puffy _____ clouds.

_____ 27. A _____ usually brings a storm which is composed of lightening, thunder, wind, and rain.

_____ 28. The cumulus clouds are considered the most beautiful clouds. (yes or no)

_____ 29. The first indication of a change in the weather is the cumulus clouds. (yes or no)

_____ 30. The clouds which bring rain or snow are nimbus clouds. (yes or no)

THE SOLAR SYSTEM

_____ 1. The study of heavenly bodies and their movements in space is known as _____.

_____ 2. Those people who make the study of the heavenly bodies and their movements are called _____.

_____ 3. One of the most important instruments for this study is the _____ which aids observation.

_____ 4. All of space and everything in it is called the _____.

_____ 5. Although the universe is very large, it has definite limits of which scientists are aware. (yes or no)

_____ 6. The majority of what is known as the universe is _____ space.

_____ 7. A star is a huge, glowing ball of hot _____.

_____ 8. The largest groups of stars are called galaxies. (yes or no)

_____ 9. The sun belongs to the Sunny Way Galaxy. (yes or no)

___ ____ 10. Our galaxy is called the _____ _____ Galaxy.

_____ 11. The center of our solar system is the _____ which we call the sun.

_____ 12. The solar system consists chiefly of the sun and the _____ _____ which travel around it.

_____ 13. There are billions of stars in our galaxy, but only one in our solar system. (yes or no)

_____ 14. In our galaxy, there _____ (are, are not) many, many stars larger than our sun.

_____ 15. The planets receive and _____ the light of the sun. This is why they shine.

_____ 16. The side of the earth which faces toward the sun is having _____.

_____ 17. The side of the earth which faces away from the sun is having _____.

_____ 18. The sun's position in the solar system is fixed so that we know that the Earth turns because (1) _____ and
_____ (2) _____ alternate on our planet.

_____ 19. The earth turns at a relatively even rate of speed. (yes or no)

_____ 20. The earth turns on an imaginary rod called its _____ which extends from the North to the South Pole.

_____ 21. Instead of saying the earth turns, it is more correct to say that the earth (1) _____ on its (2) _____.

_____

_____ 22. A period of rotation of the earth is _____ hours.

_____ 23. An imaginary line around the middle of the earth is called the _____.

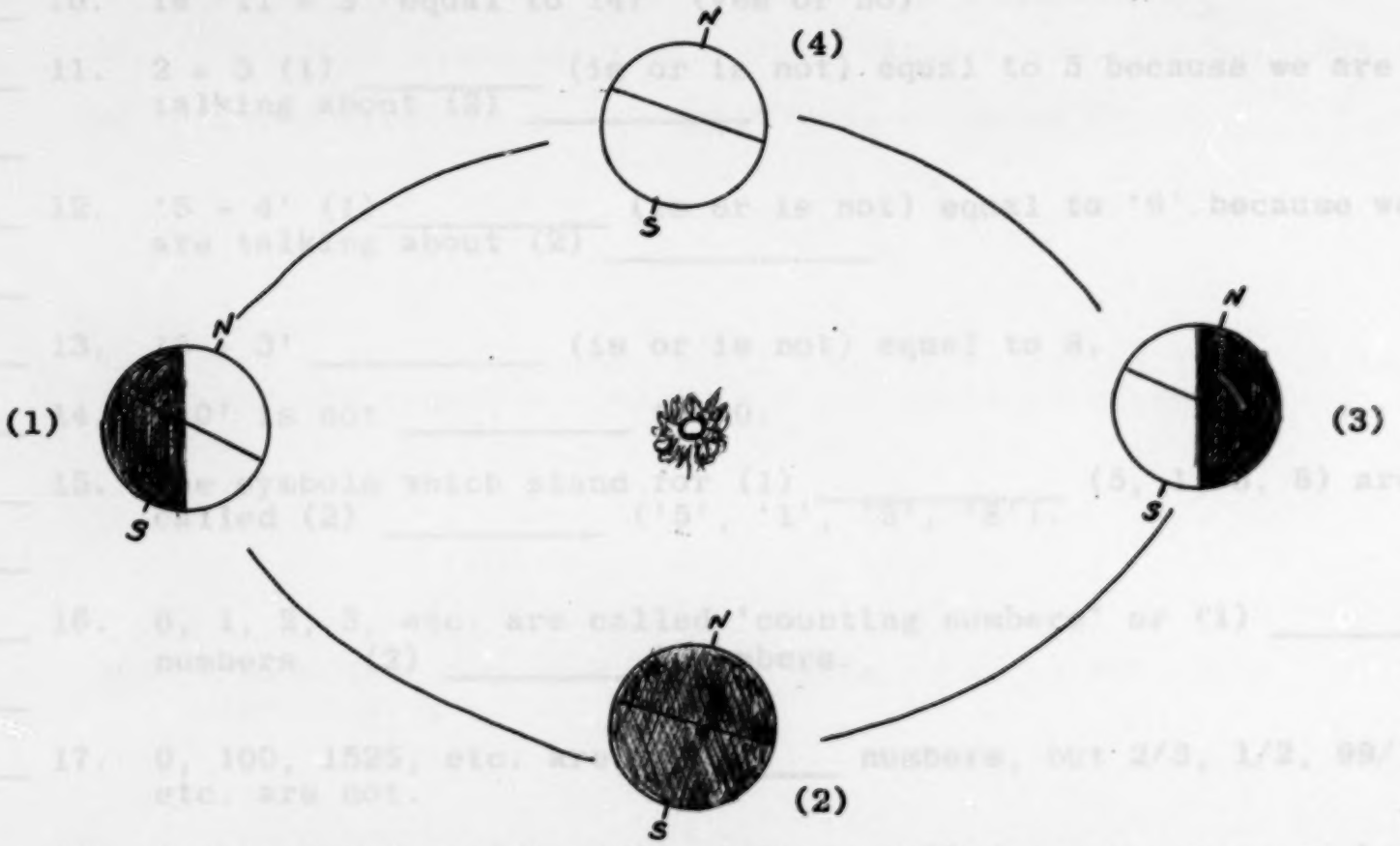
_____ 24. The earth, a sphere, is divided into two hemispheres which are called the (1) _____ _____ and the (2) _____ _____.

_____ 25. The earth is not a perfect sphere, but is flattened at the (1) _____, and it bulges at the (2) _____.

_____ 26. The earth (1) _____ around the sun, making one complete trip every (2) _____ days.

_____ 27. The path the Earth takes around the sun is a fixed one, and is called the Earth's _____.

You may write on this drawing for the answers to questions 28, 29, and 30.



28. Draw an arrow around the Earth (use position 1) to show its direction of rotation.

29. Draw arrow heads on the Earth's path around the sun to show its direction of revolution.

30. Label the diagram with the four seasons from the viewpoint of the Northern Hemisphere.

NUMBERS

_____ 1. Can you see a number? (yes or no)

_____ 2. 198 is a _____ that stands for a number.
sign signal symbol symphonic

_____ 3. Is 5 larger than 2 ? (yes or no)

_____ 4. Is '7' larger than '4' ? (yes or no)

_____ 5. 200 is a number. '201' is a(n) _____.

_____ 6. '1 + 5', '2 + 4', '3 + 3', and '12/2' are all (1) _____ which stand for the (2) _____. 6.

_____ 7. The sum of 4 and 4 is '8'. (yes or no)

_____ 8. The sum of 5 and 5 is 10. (yes or no)

_____ 9. Is 10 + 5 equal to 15? (yes or no)

_____ 10. Is '11 + 3' equal to 14? (yes or no)

_____ 11. 2 + 3 (1) _____ (is or is not) equal to 5 because we are talking about (2) _____.

_____ 12. '5 + 4' (1)_____ (is or is not) equal to '9' because we are talking about (2) _____.

_____ 13. '5 + 3' _____ (is or is not) equal to 8.

_____ 14. '10' is not _____ to 10.

_____ 15. The symbols which stand for (1) _____ (5, 1, 3, 8) are called (2) _____ ('5', '1', '3', '8').

_____ 16. 0, 1, 2, 3, etc. are called 'counting numbers' or (1) _____ numbers (2) _____ numbers.

_____ 17. 0, 100, 1525, etc. are _____ numbers, but 2/3, 1/2, 99/100, etc. are not.

_____ 18. Numbers such as 3/4, 9/10, 1/3 are called _____ numbers.

_____ 19. In order to talk about temperature and other things where the numbers are less than zero, man invented _____ numbers.

_____ 20. The numbers which answer the questions 'how much' and 'in what direction' are called _____ numbers.

21. The numbers which answer only the question 'how much' are called (1) _____ numbers and (2) _____ numbers.

22. '+5' stands for 5 (1) _____ 0.

    '-5' stands for 5 (2) _____ 0.

23. +5 is read '(1) _____5'

    -5 is read '(2) _____ 5'

24. Which of the following are not integers?
    -1, +4/5, +4, -10/3

25. Using signs, 0 can be written either (1) _____ or (2) _____.

26. Those numbers above 0 are called (1) _____ numbers.

    Those numbers below 0 are called (2) _____ numbers.

27. Write the number(s) that is/are neither positive nor negative.

28. Draw a directed number scale from -4 to +4.

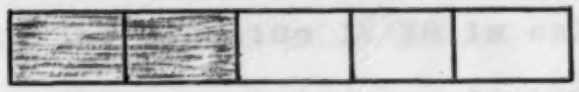
29. Draw a directed number scale from -4 to +4 and label it to show the negative numbers and the positive numbers.

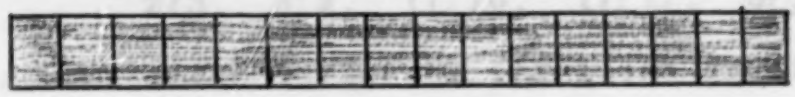
30. Draw a directed number scale from -4 to +4 with dots representing -3 and $1\frac{1}{2}$.

FRACTIONS

Write a fraction which tells how much of each of the following rectangles is shaded.

_____ 1.

_____ 2. 

_____ 3. 

_____ 4. The fraction 7/9 means (1) _____ of (2)_____ equal parts.

_____

_____ 5. The fraction _____ means 4 of 11 equal parts.

_____ 6. Each equal part of the rectangle in question 2 above is called a(n) _____.

_____ 7. Each equal part of the rectangle in question 3 above is called a(n) _____.

_____ 8. Draw one rectangle and shade 2 thirds of the rectangle.

_____ 9. Draw one rectangle and shade 4/4 of the rectangle.

_____10. Write the whole number as the indicated fraction. 8 = (thirds)

_____11. 1 = _____ (eights)

_____12. The whole number 1 and the fraction 10/10 name the same amount of disks. (yes or no)

_____13. The whole number 5 and the fraction 5/5 name the same amount of disks. (yes or no)

_____ 14.

_____

(1) What fraction describes the shaded area of the disk above?

(2) Each of these parts is called a(n) _____.

_____15. What whole number tells how many disks are shaded in problem 14?

_____16. How many whole disks can be made from 12 fourths?

_____ 17. Show by a drawing how many whole disks can be made from 6 equal halves.

_____ 18. 28 sevenths ÷ 7 sevenths = _____ disks.

_____ 19. 24 sixths ÷ _____ _____ = 4 disks.

_____ 20. Write an equation to answer the question "How many disks can be made from 21 thirds cut from some disks?"

_____ 21. The fraction 18/18 is called a(n) _____ fraction.

_____ 22. From the following lists of fractions, write the ones which indicate an amount larger than one whole.
2/3, 3/2, 17/16, 17/17, 5/15, 27/27

_____ 23. Write the following fractions as whole numbers.

_____ (1) 16/4 (2) 12/3

_____ 24. Write the following fractions as whole numbers.

_____ (1) 100/10 (2) 10/10

_____ 25. Consider the fraction 5/7. The 5 is called the _____ of the fraction.

_____ 26. Again consider 5/7. The 7 is called the _____ of the fraction.

_____ 27. The part of the fraction that tells you how many parts the whole is divided into is called the _____ of the fraction.

_____ 28. The part of the fraction that tells you how many of the parts are shaded is called the _____ of the fraction.

_____ 29. The fraction 9/4 is called a(n) (1) _____ fraction.

_____ The fraction 4/9 is called a(n) (2) _____ fraction.

_____ 30. If a fraction names exactly one or more than one whole disk, it is called a(n) (1) _____ fraction.

_____ If a fraction names less than one whole disk, it is called a(n) (2) _____ fraction.

INSECTS

_____ 1. The study of insects is called _____.

_____ 2. All insects have _____ (how many) legs.

_____ 3. Because spiders have eight legs we know that they _____ (are or are not) insects.

_____ 4. Every insect has three parts or sections that make up its _____.

_____ 5. The antennae are on the main part called the _____.

_____ 6. The section from which the legs come is called the _____.

_____ 7. The openings which allow the insects to breath are found in the _____.

_____ 8. An insect may have _____ kind(s) of eyes.
one two three many

_____ 9. The kind of eye that allows the insect to see things that are far away is the _____ eye.

_____ 10. If the eyes mentioned in question 9 are not enough the insect may have a _____ eye.

_____ 11. The technical name for feelers is _____.

_____ 12. Although the use of the feelers may differ for different insects, the size is always the same. (yes or no)

_____ 13. In addition to possibly helping an insect send or receive messages, feelers may help them to (1) _____, _____ (2) _____, or (3) _____.

_____

_____ 14. The mouth parts of some insects are so weak that they are useless. (yes or no)

_____ 15. Insects with mouth parts such as a grasshopper have _____ their food.

_____ 16. Insects with mouth parts such as moths that feed on plant juices _____ their food.

_____ 17. A mosquito must first (1) _____ the surface and then (2) _____ its food.

_____

_____ 18. Mouth parts of insects vary because of the different kinds of food upon which they feed. (yes or no)

_____ 19. The type of legs and feet that any insect may have depends on the use or need of that insect for them. (yes or no)

_____ _____ 20. The _____ _____ on a fly's feet allows it to hang on the ceiling.

_____ 21. An insect must have at least one pair of wings. (yes or no)

_____ 22. The wings of the insect are usually found in the third segment of the _____.

_____ 23. The openings in an insect's body which take in are called _____.

_____ 24. Most ovipositors are found at the end of the body section called the _____.

_____ 25. The hard case that forms the skeleton of an insect is called a chitin. (yes or no)

_____ 26. A 'skeleton' of an insect differs from that of a man in that a man's skeleton is on the (1) _____ of the body,
_____ but an insect's 'skeleton' is on the (2) _____ of the body.

_____ 27. A mouth part that is like a long coiled up tube would probably be used for _____.

_____ 28. The "little eyes" of the large compound eye are called spiracles. (yes or no).

_____ 29.

_____

This (1) _____ (is or is not) an insect because it has (2) _____.

_____ 30. People who study about insects are called _____.